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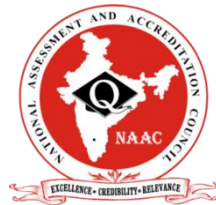
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Title: A Study on relations among consecutive Integers and its Applications

Name of Author/s: **Md. Shahidul Islam Khan** and Mazibar Rahman

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A STUDY ON RELATIONS AMONG CONSECUTIVE INTEGERS AND ITS APPLICATIONS

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ABSTRACT
In this paper, we study on relations among consecutive elements of an equivalence class of congruence modulo m for any positive integer m . If x, y, z are any three consecutive elements of an equivalence class of congruence modulo m , then $y^2 = xz + m^2$. This is a very simple relation but unknown. For $m = 1$, we get the relation $y^2 = xz + 1$ between any three consecutive integers x, y, z . We can extend the relation to any finite number of consecutive integers. Using these relations, we prove some new results and solve quadratic congruence of odd prime modulus. Uses of this relations are the merit of this paper.

AMS Mathematics Subject Classification: 11N69, 11B39, 11A07, 11A41, 11A99.

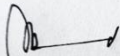
KEY WORDS: Consecutive elements, consecutive integers, equivalence class, consecutive triples, Fibonacci's numbers, quadratic congruence.

INTRODUCTION:
Let m be a fixed positive integer. For integers a and b , we define a relation \mathcal{R} on \mathbb{Z} as $a\mathcal{R}b \Leftrightarrow a \equiv b \pmod{m}$. Then \mathcal{R} is an equivalence relation on \mathbb{Z} . This relation is called congruence modulo m . This relation has m distinct equivalence classes namely, $[0], [1], [2], \dots, [m-1]$. If x, y, z are any three consecutive elements of an equivalence class of congruence modulo m , then $y^2 = xz + m^2$. In particular, if x, y, z are any three consecutive elements of $[0]$, then there exists three consecutive integers a, b, c such that $x=am, y=bm, z=cm$ and $b^2 = ac + 1$. If $a_1, a_2, a_3, \dots, a_{n-1}, a_n, a_{n+1}$ ($n \geq 2$) are consecutive elements of an equivalence class of congruence modulo m , then $a_1^2 + a_2^2 + \dots + a_n^2 - a_1a_2 + a_2a_3 + \dots + a_{n-1}a_{n+1} + (n-1)m^2$.

In particular, if $a_1, a_2, a_3, \dots, a_{n-1}, a_n, a_{n+1}$ ($n \geq 2$) are consecutive elements of $[0]$, then there exists $n+1$ consecutive integers $b_1, b_2, b_3, \dots, b_{n-1}, b_n, b_{n+1}$ ($n \geq 2$) such that $a_1 = b_1m, a_2 = b_2m, \dots, a_{n+1} = b_{n+1}m$ and $b_1^2 + b_2^2 + \dots + b_n^2 - b_1b_2 + b_2b_3 + \dots + b_{n-1}b_{n+1} + (n-1)m^2$.

PRELIMINARIES:
Definition 2.1: Any three consecutive integers x, y, z satisfy $y^2 = xz + 1$. The order tripled (x, y, z) is called consecutive triple. For a fixed positive integers $m, (mx+r, my+r, mz+r)$ where $r \in \{0, 1, 2, \dots, m-1\}$ is called consecutive triple of congruence modulo m .
Definition 2.2: [1] A Pythagorean triple consists of three positive integers a, b, c such that $a^2 + b^2 = c^2$. Such a triple is commonly written as (a, b, c) . If (a, b, c) is a Pythagorean triple, then so is (ka, kb, kc) for any positive integer k .
Definition 2.3: [2] We define a sequence of numbers as $f_1 = 1, f_2 = 1$ and $f_n = f_{n-1} + f_{n-2}$ for all $n \geq 3$. The number f_n is called the n th Fibonacci's number.
We have the following properties of Fibonacci's numbers for each $n \in \mathbb{N}$:

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SI No. 2

Title: *In situ* development of bio-based polyurethane-blend-epoxy hybrid materials and their nanocomposites with modified graphene oxide via non-isocyanate route

Name of Author/s: Simanta Doley, Asish Samah, Chandrama Sarkar, Swapan K. Dolui

***In situ* development of bio-based polyurethane-blend-epoxy hybrid materials
and its nanocomposites with modified graphene oxide via non-isocyanate
route**

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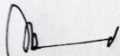
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ABSTRACT: In this work, we developed a series of sunflower oil based non-isocyanate polyurethane (NIPU)-blend-epoxy hybrid materials (HNIPU) and its nanocomposites with amine functionalized graphene oxide (AF-GO). Firstly, the carbonated sunflower oil (CSFO) containing five-membered cyclocarbonate groups was synthesized by the reaction of epoxidized sunflower oil (ESFO) with carbon dioxide (CO₂) at pressure 50 bar and temperature 120 °C. Then, A series of HNIPUs were synthesized by using a mixture of CSFO and the commercially available epoxy resin at different weight percentages (10, 20, and 30 wt% with respect to CSFO) by using isophorone diamine as the curing agent. The HNIPU with 30 wt% epoxy showed the highest mechanical properties. Finally, the nanocomposites of 30 wt% HNIPU based composition were prepared with different wt% of AF-GO (0.3, 0.6 and 1.0 wt%) and were characterized by using FTIR, ¹HNMR, XRD and SEM techniques. These results emphasize the potentiality of this environmentally friendly approach to prepare renewable HNIPU and its nanocomposite materials of high performances.

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SI No. 1

Title: Multifunctional Ternary Nanocomposites of Ni/Polypyrrole/Reduced Graphene Oxide as Supercapacitor and Electrocatalyst in Methanol Oxidation

Name of Author/s: Chandrama Sarkar, Jayashree Nath, Shilpa Bhuyan, Swapan K. Dolui



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Multifunctional Ternary Nanocomposites of Ni/Polypyrrole/Reduced Graphene Oxide as Supercapacitor and Electrocatalyst in Methanol Oxidation

Chandrama Sarkar, Jayashree Nath, Shilpa Bhuyan, and Swapan K. Dolui^{*[a]}

In this work the concurrent electrochemical energy storage and conversion characteristics of Ni nanoparticles supported on polypyrrole-reduced graphene oxide (Ni/PPy/rGO) nanocomposite is reported. Ni/PPy/rGO nanocomposite was synthesized by mixing its precursors PPy/rGO and $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$, where Ni^{2+} was reduced to Ni at pH 10.5. The obtained nanocomposite is characterized using FTIR, XRD, Raman Spectroscopy, SEM and dynamic light scattering methods. The electrochemical energy storage properties of the nanocomposite are investigated using cyclic voltammetry, galvanostatic charge/discharge and electrochemical impedance spectroscopy tests. Electrochemical analysis reveals that Ni/PPy/rGO nanocomposite has high specific

capacitance of 763.49 Fg^{-1} at 1.31 Ag^{-1} current density with capacity retention of 96.75% after 200 cycles Ni/PPy/rGO nanocomposite is also used as electrode in methanol electro-oxidation. Cyclic voltammetry and chronoamperometry are carried out to study the electrochemical energy conversion properties of the composite towards methanol electro-oxidation. The anodic current density of the Ni/PPy/rGO nanocomposite is much higher than that of Ni/rGO and PPy/rGO. Moreover, the onset potential of Ni/PPy/rGO nanocomposite is much lower than that of Ni/rGO and PPy/rGO. The results show that the Ni/PPy/rGO nanocomposite is electro-catalytically active and highly stable.

Introduction

The rapid exhaustion of conventional fossil fuel reserves the increasing concern over environmental pollution has encouraged intensive research and development of new materials to improve the performance of advanced energy conversion and storage devices.^[1-2] The electrochemical energy production will be considered as an alternative energy/power source if energy consumption is designed to be of high-performance, low-cost and environmental friendly manner. System required for promising electrochemical energy storage and conversion include fuel cells, batteries and electrochemical capacitors.^[3] Supercapacitors are gaining considerable interest because of their higher energy density and power density than batteries, faster charging time and more excellent cyclability.^[4,5] Direct methanol fuel cells (DMFCs) have also recognized to be a promising power source for portable electronic devices and vehicles, due to the abundance of their raw materials, high efficiency and low emission.^[26,7] It is necessary to develop multi-functional, low cost electrode materials which possess reasonably good performance to develop advanced supercapacitors and DMFCs.

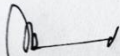
Depending on the charge storage mechanisms supercapacitors are mainly classified into two broad categories. First

category is electrical double layer capacitance (EDLC), which stores energy based on the reversible adsorption/desorption of ions that takes place at the interface between the electrode materials and the electrolyte. EDLC is based on carbonaceous materials that possess high power density but low capacitance. Carbonaceous materials have a common capacitance value of less than $40 \mu\text{F cm}^{-2}$ of the real surface, which is an immense weakness for EDLC.^[8-10] Another category is pseudocapacitor, a pseudocapacitor stores energy from rapid surface redox reactions that takes place on the surface and the near surface of the electrode materials. Pseudocapacitor based on metals, metal oxides or conducting polymers possesses high specific capacitance but due to low conductivity it suffers from poor cyclability.^[11] Hybridizing EDLC and a pseudocapacitor can enhance the electrochemical performance.^[12,13] For example, Subramaniam et al.^[13] reported that amorphous MnO_2 single walled carbon nanotube composites showed enhanced electrochemical properties both with respect to high rate capability and the discharged capacitance due to the inter-connection of MnO_2 and SWNTs.

DMFCs possess high energy density and easy solubility of raw materials compared to hydrogen fuel cells.^[14] However, high manufacturing costs and slow rate of methanol oxidation reaction on the anode of the fuel cell have limited the commercialization of these fuel cells.^[15] In order to overcome these problems a great deal of research has been carried out including detailed studies on Pt-based electro-catalysts in acidic medium.^[16-18] But unfortunately, the commercialization of the Pt electrocatalyst is significantly hindered by the limited resource of Pt, high cost, low power density and poor CO-poisoning tolerance.^[19] We are searching for a new low cost

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SI No. 1

Title: Speaker Diarization with Deep Learning Techniques

Name of Author/s: **Kshirod Sarmah** and Swapnanil Gogoi.

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SPEAKER DIARIZATION WITH DEEP LEARNING TECHNIQUES

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ABSTRACT

Speaker diarization is a task to identify the speaker when different speakers spoke in an audio or video recording environment. Artificial intelligence (AI) fields have effectively used Deep Learning (DL) to solve a variety of real-world application challenges. With effective applications in a wide range of subdomains, such as natural language processing, image processing, computer vision, speech and speaker recognition, and emotion recognition, cyber security, and many others, DL, a very innovative field of Machine Learning (ML), that is quickly emerging as the most potent machine learning technique. DL techniques have outperformed conventional approaches recently in speaker diarization as well as speaker recognition. The technique of assigning classes to speech recordings that correspond to the speaker's identity is known as speaker diarization, and it allows one to determine who spoke when. A crucial step in speech processing is speaker diarization, which divides an audio recording into different speaker areas. In-depth analysis of speaker diarization utilizing a variety of deep learning algorithms that are presented in this research paper. NIST-2000 CALLHOME and our in-house database ALSD-DB are the two voice corpora we used for this study's tests. TDNN-based embeddings with x-vectors, LSTM-based embeddings with d-vectors, and lastly embeddings fusion of both x-vector and d-vector are used in the tests for the basic system. For the NIST-2000 CALLHOME database, LSTM based embeddings with d-vector and embeddings integrating both x-vector and d-vector exhibit improved performance with DER of 8.25% and 7.65%, respectively, and of 10.45% and 9.65% for the local ALSD-DB database.

Keywords: Speaker Diarization; Machine Learning; MFCC; Deep Learning

1. INTRODUCTION

Speaker Diarization (SD) is the process of determining "who spoke when" during a multi-party conversation. Without any prior information of the speakers or the number of speakers in the dialogue, SD seeks to identify all the utterances made by each speaker. Speech analytics and transcription systems heavily rely on the process of segmenting and categorizing an audio recording into different speaker segments. Applications like audio indexing, transcription, and sentiment analysis all depend on SD. In SD, the sub-tasks of speaker segmentation and speaker clustering may be seen. While speaker clustering refers to gathering all speaker turns that are associated with one speaker, speaker segmentation looks for the speaker in relation to limits.

A few years ago, speaker adaptive processing was made possible by the development of SD algorithms for voice identification on multi-speaker audio recordings. A variety of audio data broadcast from different media stations, conference conversations, private videos from online social media, business meetings, court sessions, etc. may all be efficiently indexed or analyzed using SD. In essence, an SD system is made up of numerous separate sub-modules. Several front-end processing approaches, such as voice augmentation, speech separation, or target speaker extraction are utilized to minimize any artifacts in auditory settings. The selected speech segment's raw speech signals are converted to their comparable acoustic characteristics or embedding vectors. The altered speech segments are classified and speaker courses' label during the clustering phase, and the clustering findings are further refined during the post-processing phase. The most cutting-edge improvements in SD have been accomplished right now. On the other hand human perception is almost entirely capable of performing speaker diarization without knowing the fundamentals of language, and the process can be completed on the spot without specialized knowledge of the languages spoken by various speakers. In this study, we investigate new improvements made feasible by cutting-edge deep learning techniques as well as the evolution of speaker diarization across time.

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SI No. 1

Title: ZnS NPs enhanced Eu³⁺ photoluminescence in the sol-gel silica matrix

Name of Author/s: P. Dutta, S. Boro, P Borthakur, P.P. Konwar, **D. Kakoti**, P. Gogoi

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ZnS NPs enhanced Eu³⁺ photoluminescence in the sol-gel silica matrix

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ABSTRACT

ZnS co-doped Eu³⁺ Silica matrices were fabricated by sol-gel route. The fabricated matrix was naturally characterized by XRD and EDX. Optical characterizations were performed by Absorption as well as PL Spectroscopy. Structural characterizations show the presence of ZnS particles (ZnS NPs) embedded in the Eu³⁺ doped Silica matrix. The study reveals an increase in PL intensity with ZnS concentration owing to the structural modification of the Eu³⁺ in the host matrix as well as energy transfer from the ZnS NPs to Eu³⁺ ions. The observations are discussed in the light of Judd Ofelt intensity parameters as well as radiative parameters.

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1. Introduction


Rare earths (RE) form an important class of optical materials. These are very promising active ions with a lot of applications, viz. in the field of lasers, colour displays, remote sensing, data storage, optical communications, photovoltaics, sensors and so on [1–3]. REs are the lanthanides with electronic configuration [Xe]4f^{0–14}5d^{0,1}6s² along with Scandium ([Ar]3d¹4s²) and Yttrium ([Kr]4d¹5s²) and generally exist in the tri-positive state. The partially filled 4f shells shielded by 5s and 5p shells lead to intra-configurational 4f-4f transitions yielding characteristic sharp absorption in the ultraviolet – visible (UV-Vis) region and sharp as well as stable emission in the visible – near infra red (Vis-NIR) region. Even though these RE transitions are sharp, they possess significantly low absorption co-efficient leading to their low emission intensities. Moreover, in free state, the RE electronic transitions are forbidden by Laporte's selection rule. When the RE ions are put in a suitable host, the electric field of the host removes the degeneracy of RE energy levels via Stark splitting and admixes the high energy opposite parity levels, thus making these transitions possible [4]. Europium ion (Eu³⁺) is well known for the simplest energy level structure and strong emission in the visible range. The ground state of Eu³⁺, ⁷F₀ is non-degenerate and the excited states ⁷F_J (J = 0 to 6) and ³D_J (J = 0 to 4) are well separated which make it

viable for application in phosphor and lighting technology as optical probing [4].

Among different hosts, silica glass gets large attention due to its various advantages, such as optical transparency, wide emission in the UV-Vis region, homogeneity, superior chemical and thermal stability, strong thermal resistance, non-toxicity, simple fabrication etc [5]. The silica matrices are usually prepared by the sol-gel method; the latter is a room temperature method and possesses benefits like precise control over the quality, versatility in shape and size of the products and reproducibility [6]. Even though the residual hydroxyl groups present in the silica matrix prepared by sol-gel method play a detrimental role in the Photoluminescence (PL) efficiency of RE ions, there have been continuous efforts among the scientific community towards the enhancement in optical efficiency of RE ions in silica matrix, to harness its superior physical properties and its optical transparency. Introduction of sensitizing agents, co-doping with secondary RE ions, semiconductor and metal nanoparticles (NPs) etc. are some of the methods used [7–9].

The resultant absorption by RE ions in a host matrix is augmented by modifying the host network, thus modifying the environment as well as by utilizing energy transfer from the sensitizing ions/molecules with higher absorption co-efficient. The modification of the host matrix is useful in tackling the above mentioned issue [7] as well. ZnS is a direct band-gap II-VI semiconductor with high absorption cross section in the UV-Vis region

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SI No. 2

Title: Effect of ZnS nanoparticles on the spectroscopic transitions of Ho³⁺ ions in sol-gel silica matrix

Name of Author/s: **Dibyajyoti Kakoti**, Purabi Gogoi and Pankaj Dutta.



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Effect of ZnS nanoparticles on the spectroscopic transitions of Ho³⁺ ions in sol-gel silica matrix

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ABSTRACT

ZnS NPs and Ho³⁺ co-doped silica matrices are prepared by room temperature sol-gel method. The fabricated matrices are characterized structurally by X-ray diffractometry, Transmission electron microscopy, Energy dispersive X-ray analysis and Fourier transform infrared spectroscopy. Structural studies reveal the presence of ZnS NPs in the Ho³⁺ co-doped silica matrices. Judd Ofelt analysis of UV-Visible absorption spectra shows that the phenomenological Judd Ofelt intensity parameters Ω_λ , which illustrate the intensities for transitions in lanthanides and actinides in solids as well as solutions follow the trend $\Omega_2 > \Omega_4 > \Omega_6$. Enhancement in the Ω_2 parameter with ZnS NP concentration indicates higher asymmetry and a stronger covalent environment of Ho³⁺ ions in the studied matrix, compared to some popular hosts. The four distinct PL emission bands of Ho³⁺ observed in the studied matrices show a strong dependence on ZnS NP concentration, with 0.67 M of ZnS as the optimum concentration. The enhancement in the PL emissions with ZnS NPs is attributed to the network modification and sensitization of Ho³⁺ ions by the NPs. Sensitization through energy transfer also increases the lifetime of the excited state, as observed from the PL decay study. The decrease of PL emission beyond optimum ZnS concentration is most likely due to the self-quenching of ZnS NPs. The upconversion study shows enhancement in Ho³⁺ luminescence up to 14 times with ZnS co-doping; indicating the viability of the fabricated matrix for their application in UC devices as well.

1. Introduction

Tri-positive rare-earth (RE) ions form a class of very important elements to develop potential optical materials because of their unique spectroscopic properties like sharp and stable absorption mainly in the ultraviolet (UV) and visible (Vis) regions as well as strong emission in Vis and near-infrared (NIR) regions. The RE ions as such cannot be efficiently excited by UV light due to the low absorption coefficient for the parity forbidden f-f transitions [1]. These ions do not exhibit electric dipole (E-D) transitions in their free state owing to the restriction by Laporte's selection rule. However, when these RE ions are introduced in a host, the energy levels of the RE ions split into different sub-levels due to the Stark effect or crystal field effect. Also, admixing of higher energy opposite parity levels occurs thus allowing the intra-configurational f-f transitions [2]. The suitability of the host for a particular RE ion can be estimated by the well-established Judd-Ofelt (J.O.) theory. The three J. O. parameters Ω_2 , Ω_4 , Ω_6 and the other radiative parameters such as full

width at half maximum (FWHM), fluorescence line width, spontaneous emission cross-section, the radiative lifetime of the excited states, branching ratios, figure of merit, gain bandwidth etc. of the electronic transitions are very crucial in the fabrication of potential optical materials [3,4]. These parameters are being studied for the application of RE ions in diverse areas such as Vis-IR solid-state lasers, optical amplifiers, Raman laser amplifiers, telecommunications, optical parametric oscillators, eye-safe lidar, bio-medical applications, fiber lasers, colour displays, sensors, solar cells etc [5-11].

Amongst the tri-positive RE ions, Holmium (Ho³⁺) is an important active ion with unique radiative characteristics. In general, ED transitions between Ho³⁺ energy states take place in the range from UV to IR including Vis [12,13] and the energy levels are suitable for both down-conversion (DC) and upconversion (UC) luminescence [13]. Several research works have reported efficient Ho³⁺ activated DC and UC lasers in the UV-IR region [14-21]. Ho³⁺ doped solid-state lasers have also wide applications in different branches of medical sciences

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